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Integrated Nanotechnology at Sandia

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December 8, 2005

Sandia is a Multiprogram Laboratory Operated by Sandia Corporation,
a Lockheed Martin Company, for the United States Department of Energy
Under Contract DE-ACO4-94AL85000.

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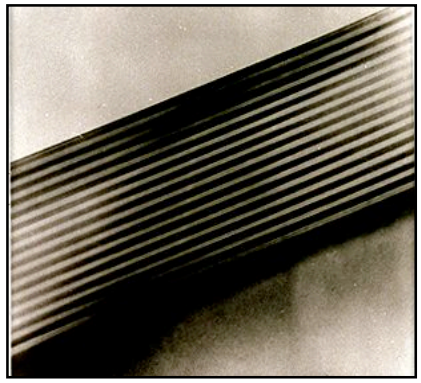
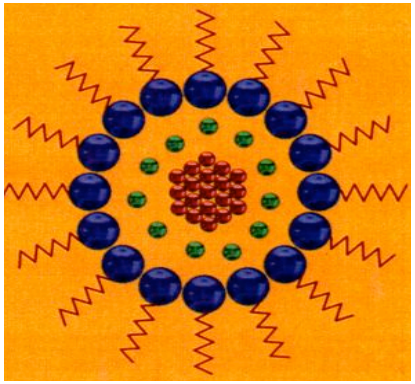
Nano-structured materials are the key to novel/enhanced functionality

Layered-Structures



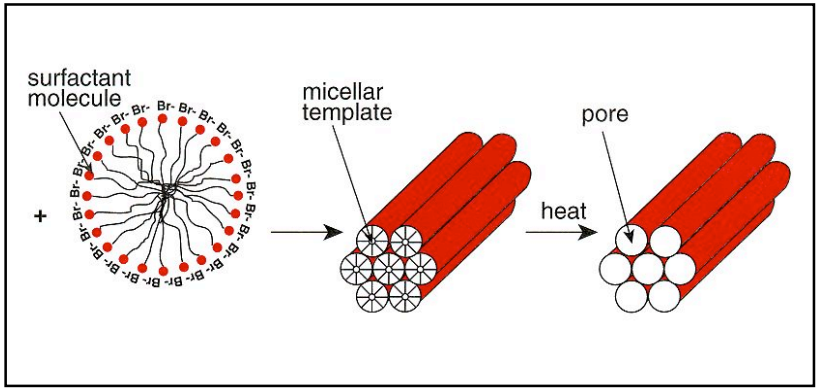
- Electronics/photonics
- Novel Magnets
- Tailored hardness

Nanocrystals



- Novel catalysts
- Tailorable light emission
- Supercapacitors

Nanocomposites



- Separation membranes
- Adaptive/responsive behavior
- Pollutant/impurity gettering

Nanosciences will enable scientifically tailored materials and lead to revolutionary advances in technology

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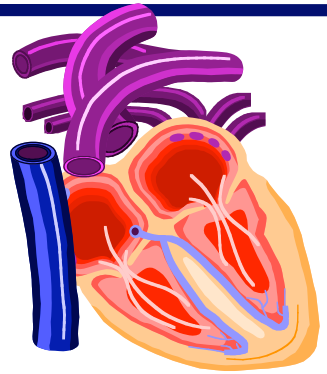
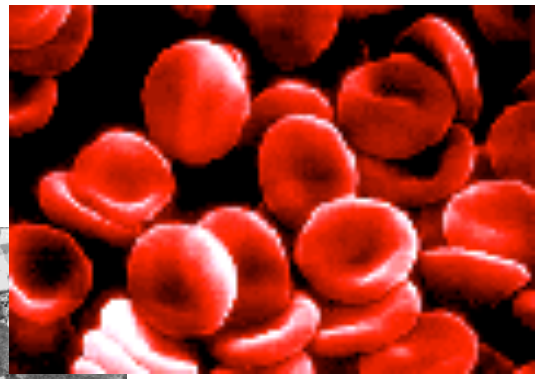
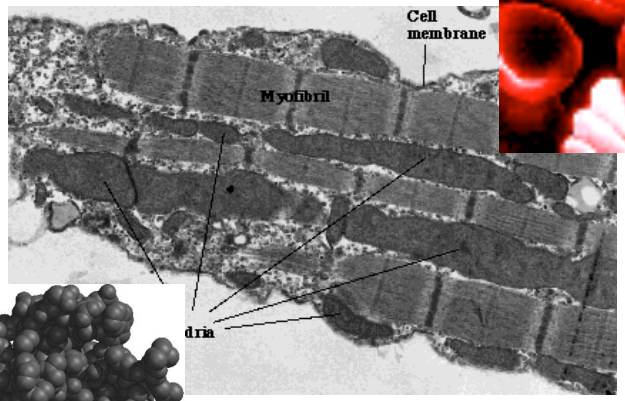
Living systems integrate nanotechnology

Nanoscale "machines" are coupled into the micro and macro world.

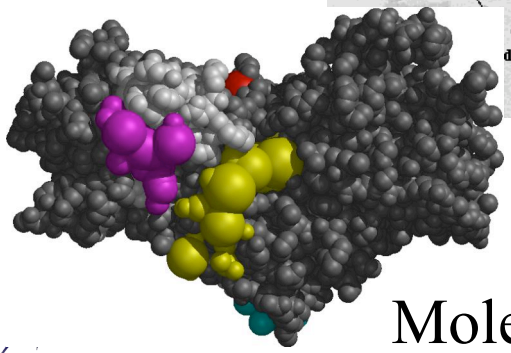


Organs and Tissues





Cells



Sub-cellular mechanical structure

Molecules and Chemical Pathways

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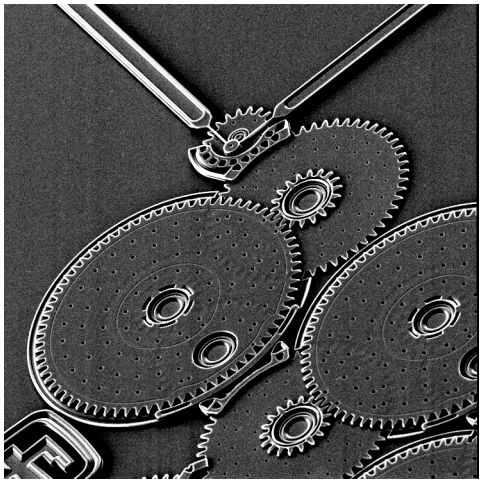
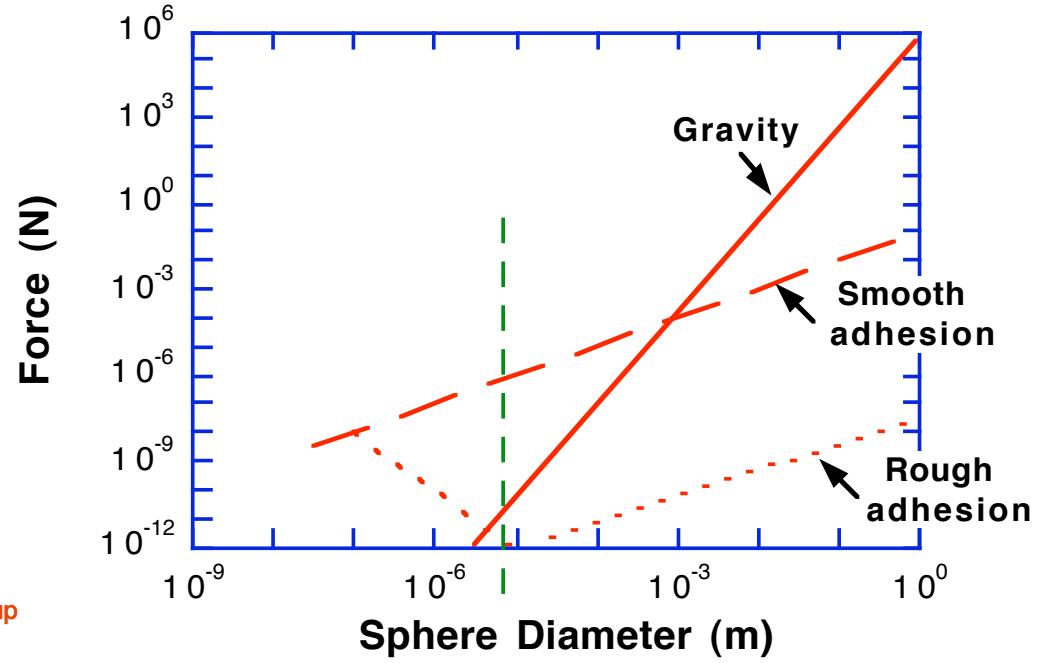
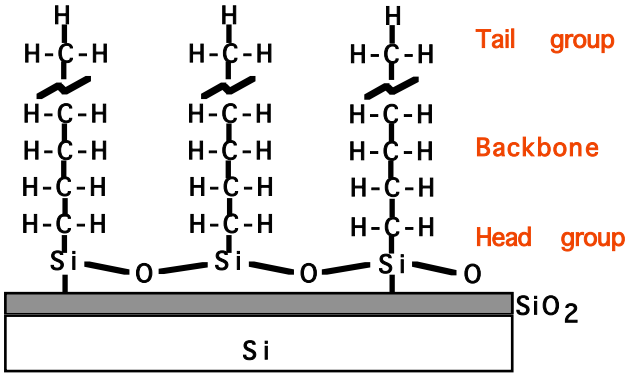
Nanotechnology fights adhesion in Sandia microsystems







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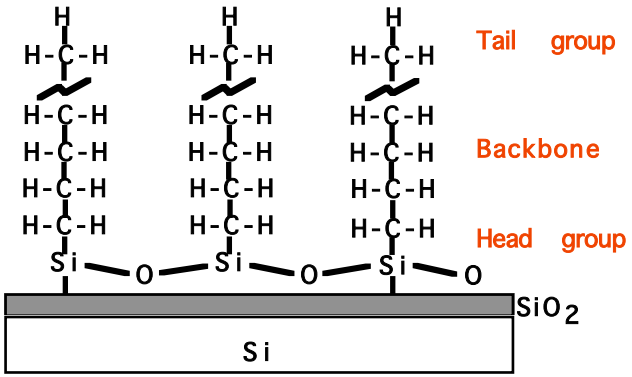
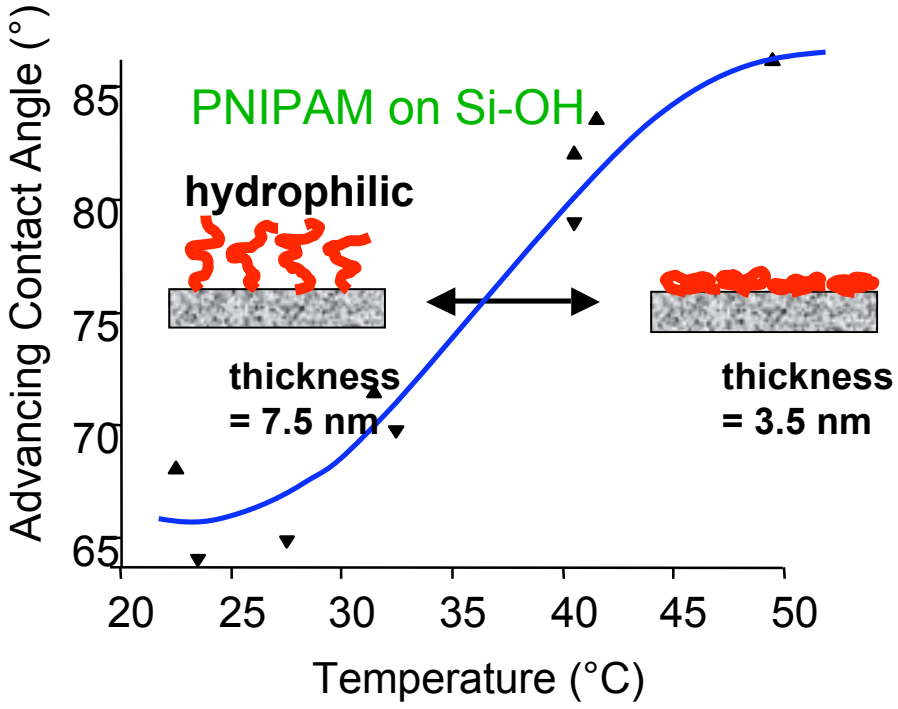
Nanoscale surface treatments to change surface properties

Static **Dynamic**





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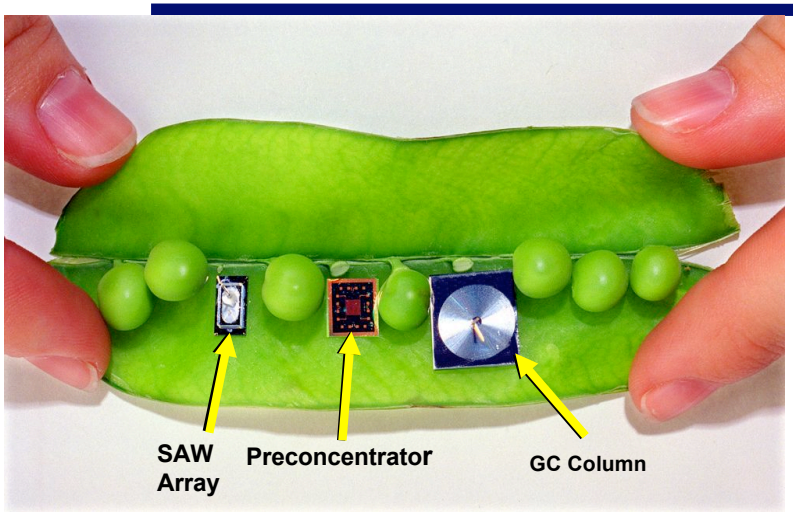
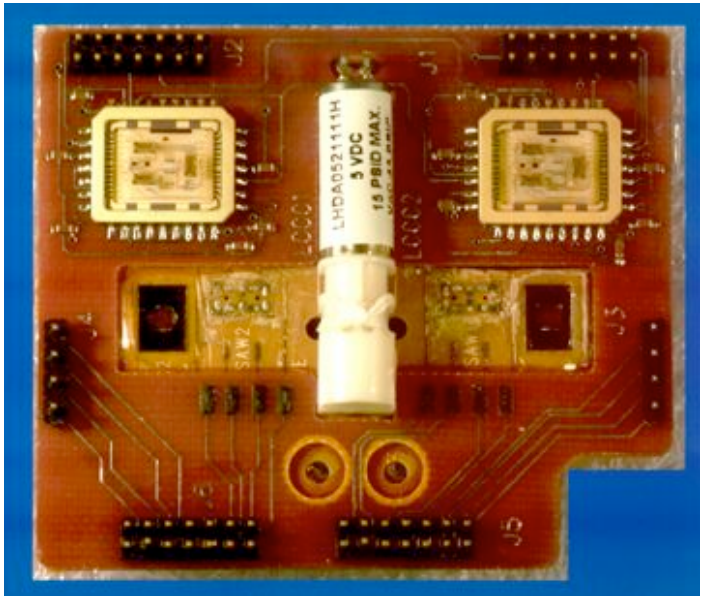
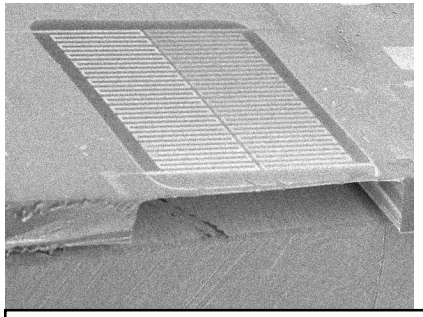
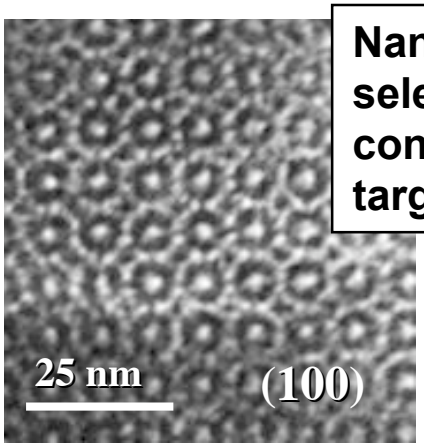
μChemLab™ is engineered down to the molecular level







Micro-scale heater



Nanoporous film selectively concentrates target analytes.

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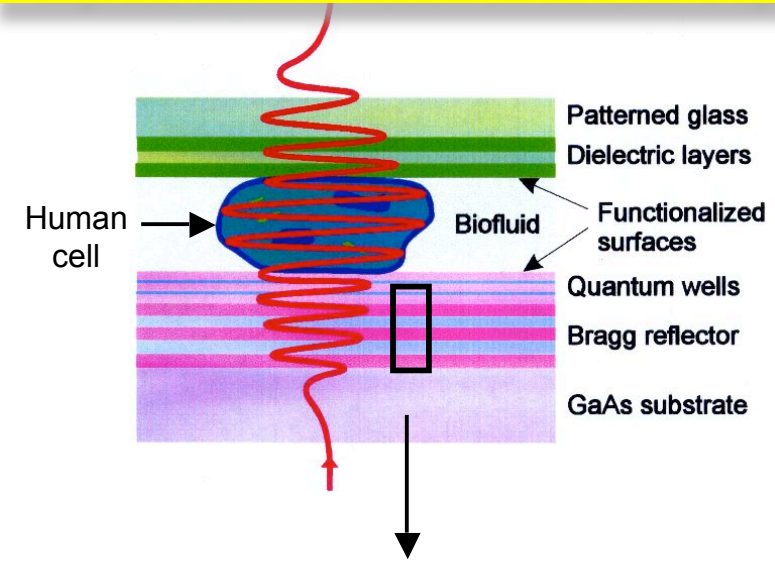
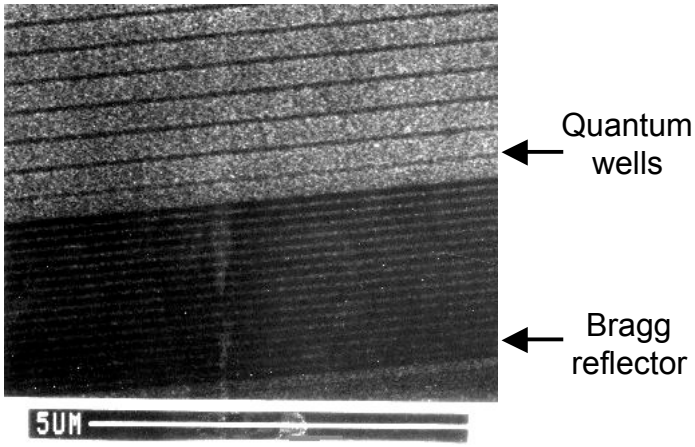
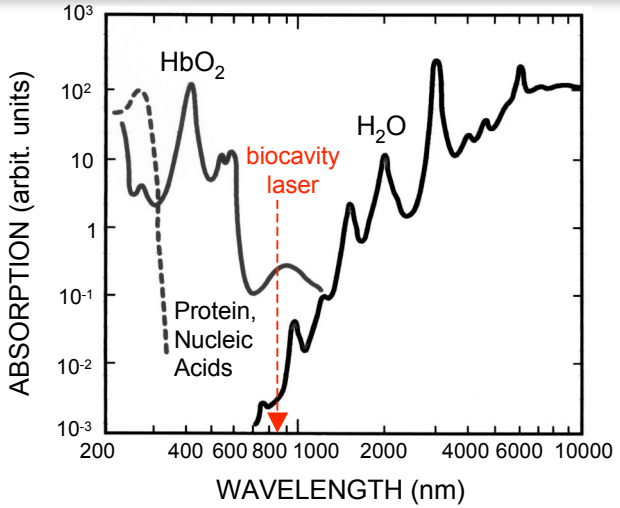
Nanotechnology enables new system functions: BioCavity Laser

Biological cells form part of a semiconductor laser and impress cell information on the laser's optical output

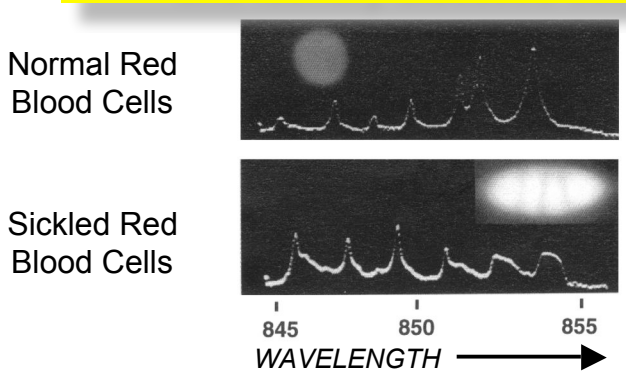




The semiconductors are tailored to emit where the cells are transparent



Unique emission signatures detect and identify diseased cells



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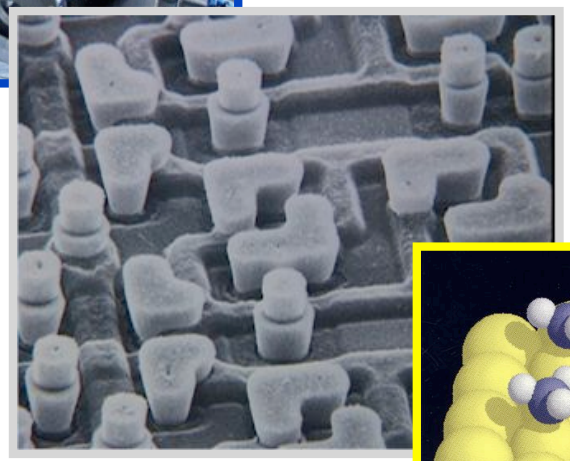
How is nano-technology different from micro-technology?

Conventional Machines

Build and assemble

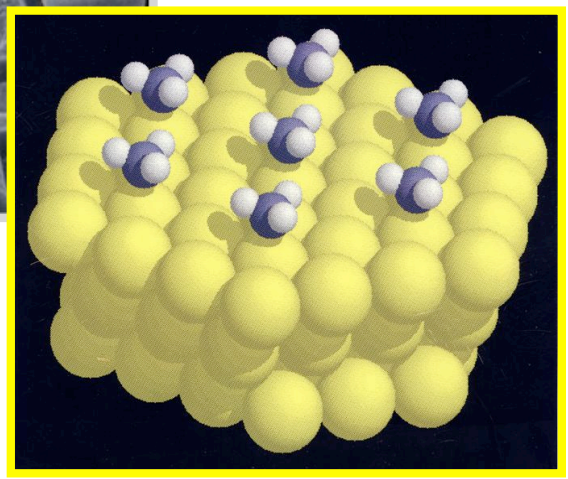
(m - mm)



Microelectronics

Top down - build in place

(10 - 0.1 µm)



Nanotechnology

Bottom up - self assembled

(1- 100 nm)

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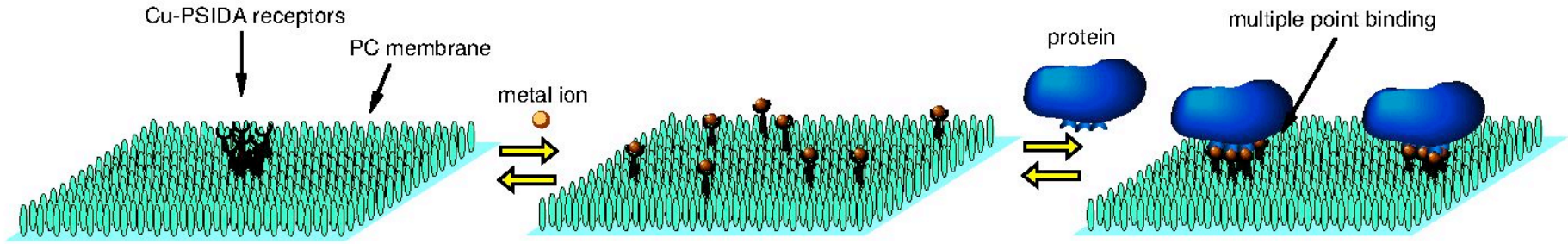
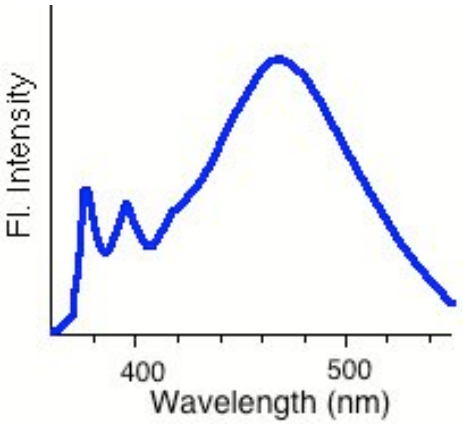
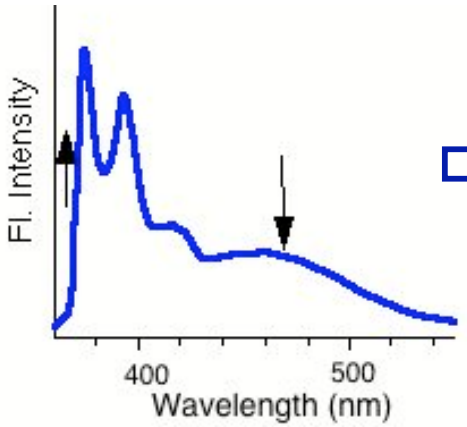
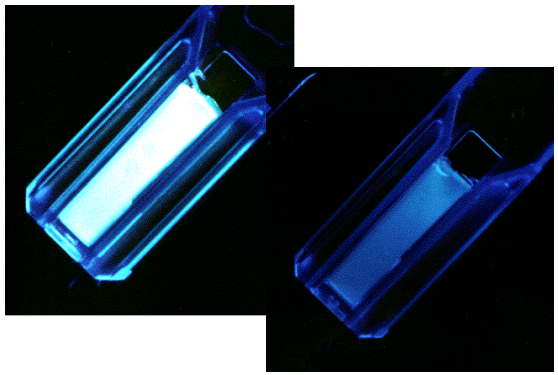
Self-organization within membrane: A new approach to molecular recognition









- **Adsorption triggers reversible aggregation of optical receptors**
- **Adsorption detected via change in optical response**

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Center for Integrated Nanotechnologies

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- Highly collaborative DOE National User Facility
- Focused on nanoscience and its integration across scientific disciplines and multiple length scales.
- Access to tools and expertise (pre-competitive or proprietary)
- Explore the continuum from scientific discovery to the integration of nanostructures into the micro and macro worlds.

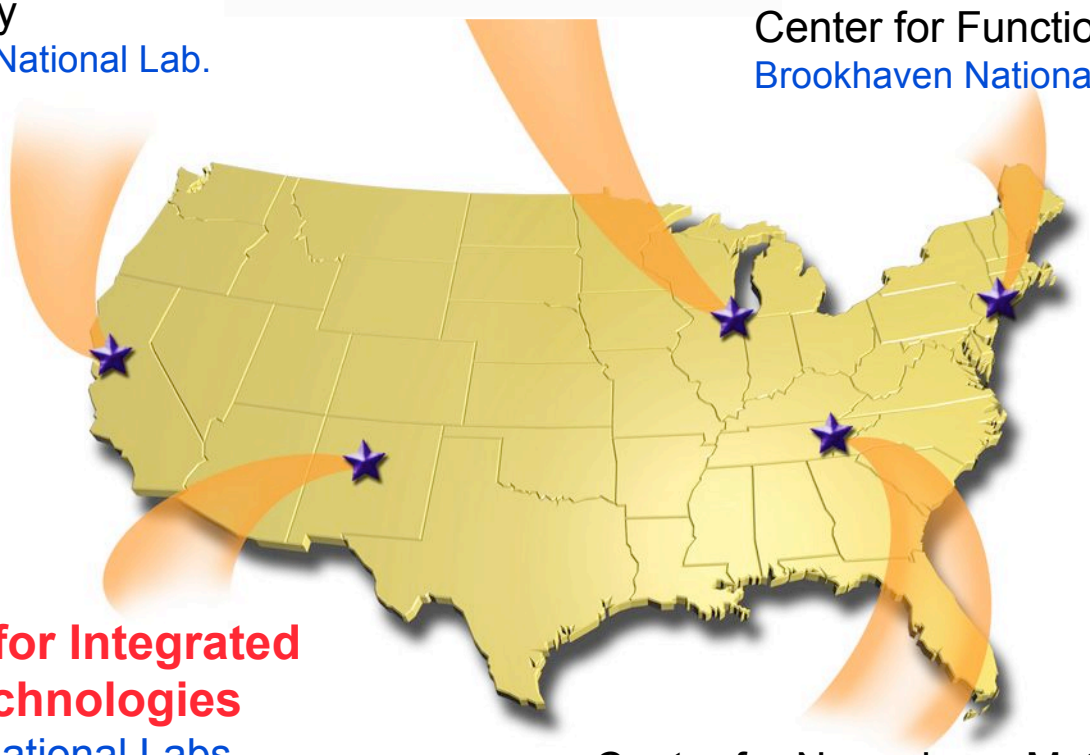
"One scientific community focused on nanoscience integration"

CINT is one of five U.S. Dept. of Energy Nanoscience Centers

Center for Nanoscale Materials
Argonne National Lab.

Molecular Foundry
Lawrence Berkeley National Lab.

Center for Functional Nanomaterials
Brookhaven National Lab.



Center for Integrated Nanotechnologies
Sandia National Labs.
Los Alamos National Lab.

Center for Nanophase Materials Sciences
Oak Ridge National Lab.

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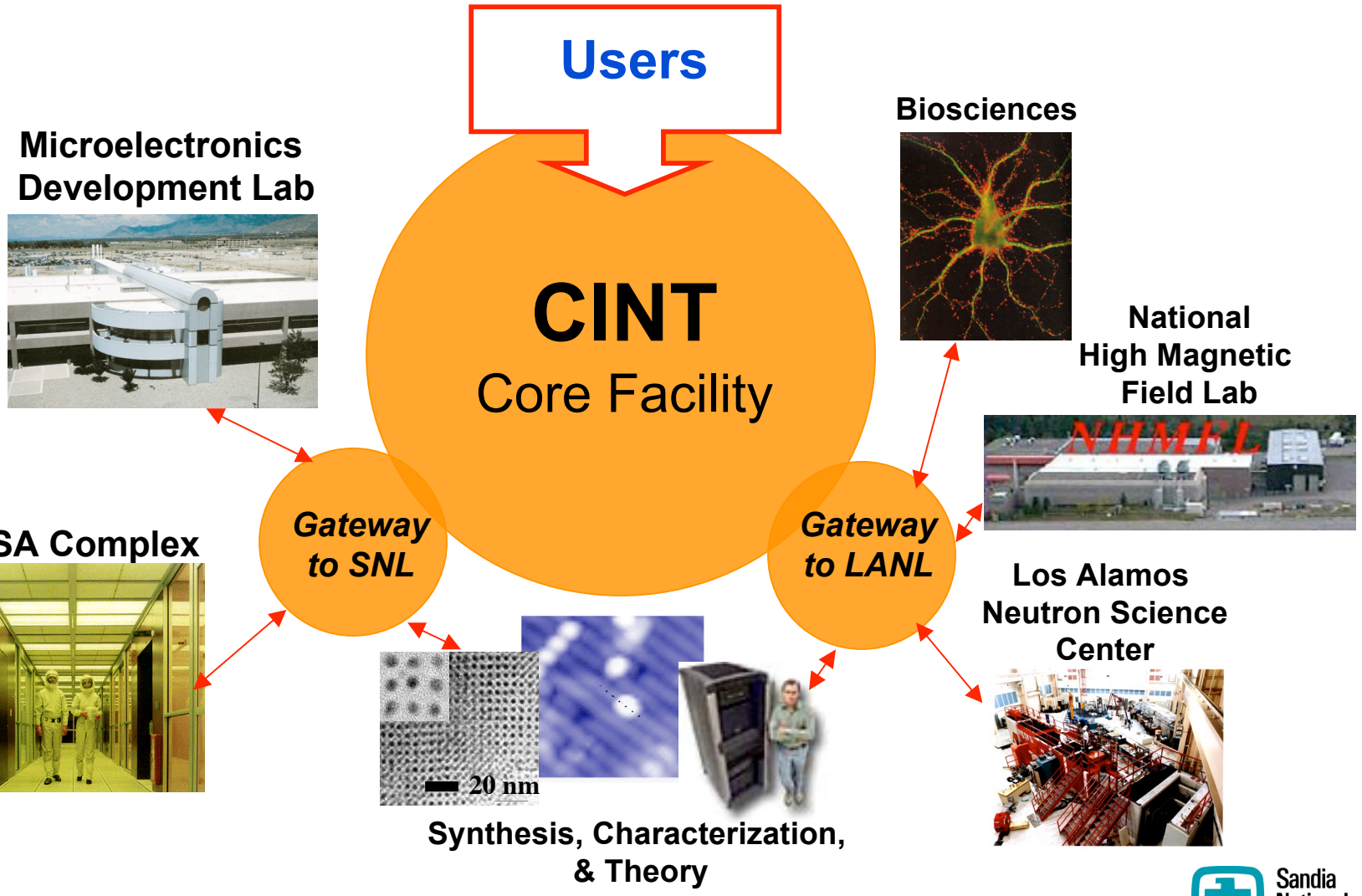
Two Laboratories creating one community focused on nanoscience integration



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The CINT Core/Gateway model embodied with physical user facilities

Core Facility in Albuquerque

CINT Gateway to Sandia
Nanomaterials/Microfabrication

CINT Gateway to Los Alamos
Nanomaterials/Biosciences

Buildings Complete	**December 2005**
Begin Operations	**April 2006**
Fully Operational	**May 2007**

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Construction Status - Core Facility

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Sandia National Laboratories

Construction Status - LANL Gateway

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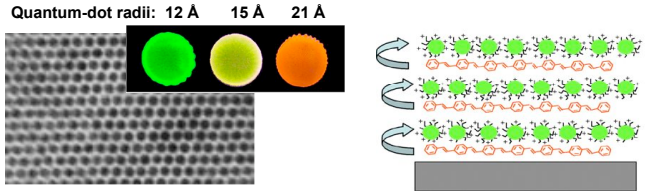
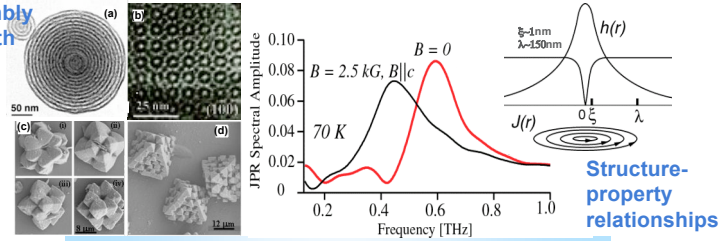
CINT Thrust Areas provide expertise for integration science challenges

Nanoelectronics & Nanophotonics:
Precise control of electronic and photonic wavefunctions



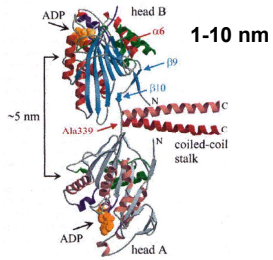
Complex FunctionalNanomaterials:
Relationships between synthesis, structure and complex and emergent properties

Self-assembly on all length scales

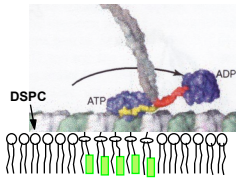


Structure-property relationships

Nano-Bio-Micro Interfaces:
Biological principles & functions imported into artificial bio-mimetic systems



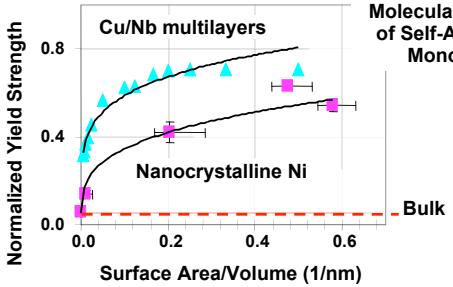
1-10 nm

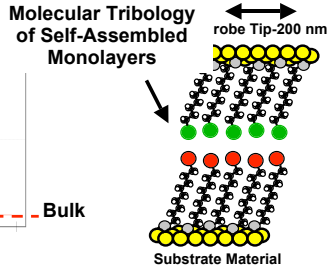


Aggregated receptors

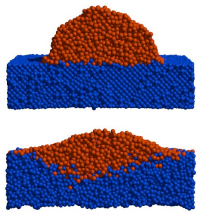
10 -100 nm

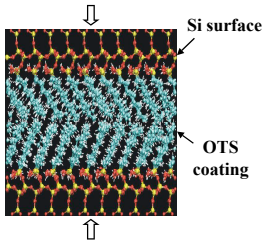
Nanomechanics:
Understanding the mechanical behavior of nanostructured materials

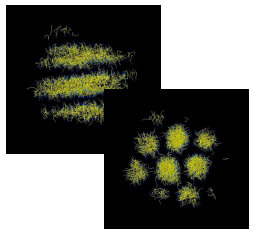




Theory & Simulation:
Theoretical, modeling and simulation techniques for multiple length and time scales and functionality







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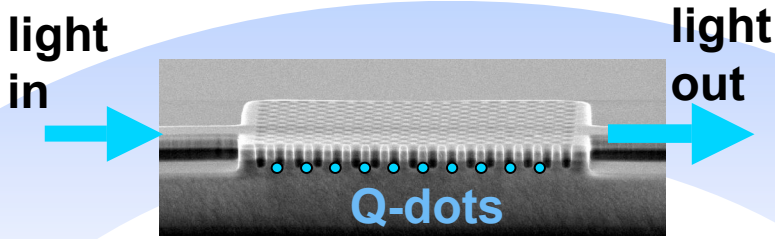
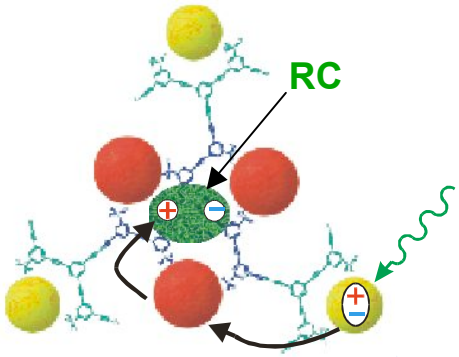
Integration Science Challenge: Energy transfer

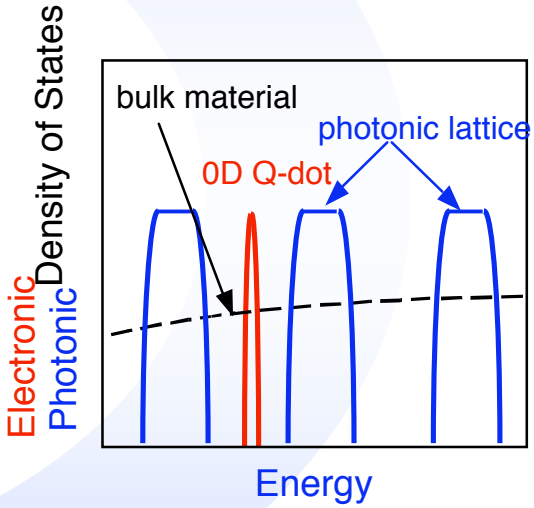


Multi-length scale integration



Nonlinear response: new behaviors for switching, sensing, energy harvesting

Technology Opportunity



Nanoscale physics

Theory and simulation

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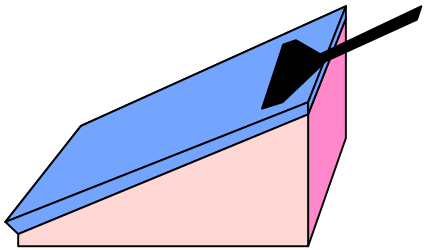
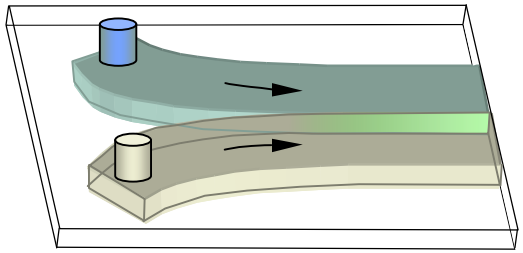
CINT Users can access a spectrum of research tools in one place

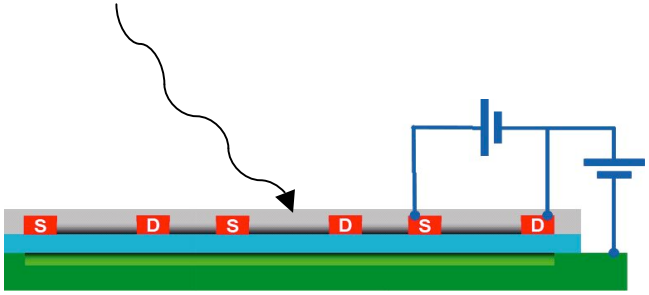
- **Micro-Nano fabrication and analysis**
- **Innovative techniques**
  - Atom Tracking STM
  - Magnetic Force Microscope
  - Interfacial Force Microscope
- **Theory and Simulation**
- **Discovery Platforms™**



nanomechanics



microfluidics



optical, transport

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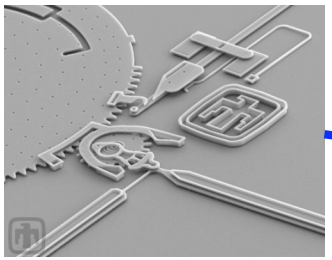
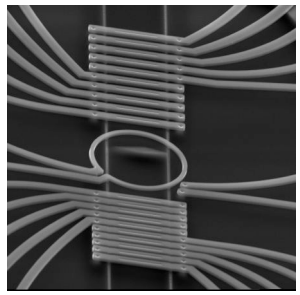
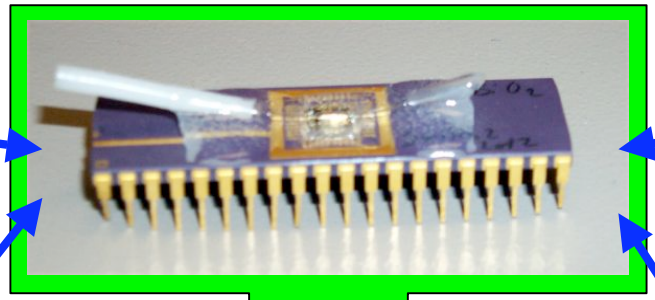
CINT Discovery Platforms™: micro-labs for nanoscience exploration

Mechanics

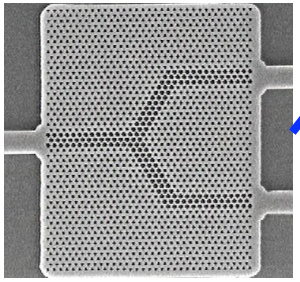


Electronics

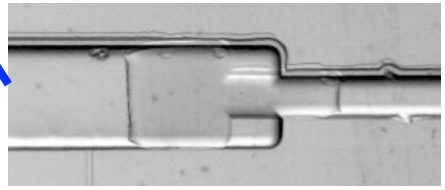


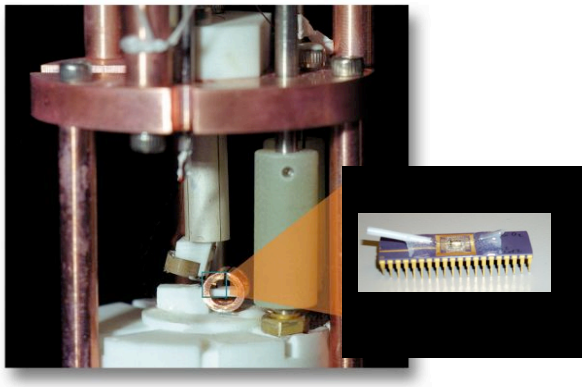


Optics



Fluidics





Discovery Platforms™ will be compatible with characterization instruments

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Researchers access CINT via the User Program

- **Universities**
  - Postdocs, students and visiting faculty researchers.
- **Industry**
  - Pre-competitive and propriety research mechanisms.
- **Other Laboratories**
  - Other Federal agencies.
- **International Science Community**
  - Open to the international science community

Key Aspects of User Program

- **Open access to facilities based on user proposal quality**
- **Spectrum of user modes**
  - **Access to equipment**
  - **Collaborative research**
  - **Multi-year projects**
- **External evaluation of proposals**
- **Mechanisms for proprietary work**
- **Normal operations start April 2006**

http://CINT.sandia.gov* or *http://CINT.lanl.gov

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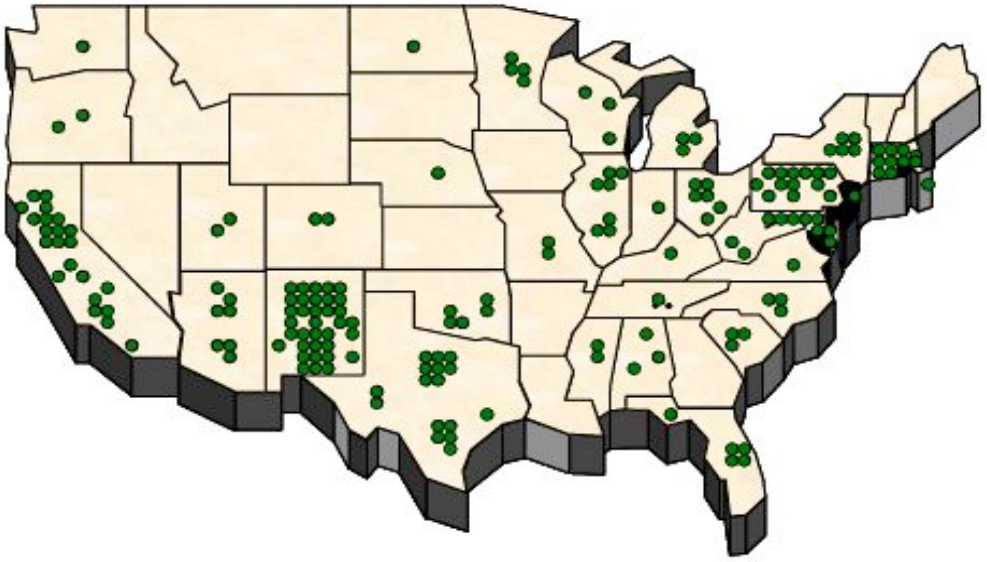
External users are already working at CINT



Jump-start User Projects

257 requests (2003-05)
89 projects approved
27 states
4 foreign countries
43 universities
5 private-sector
5 government labs

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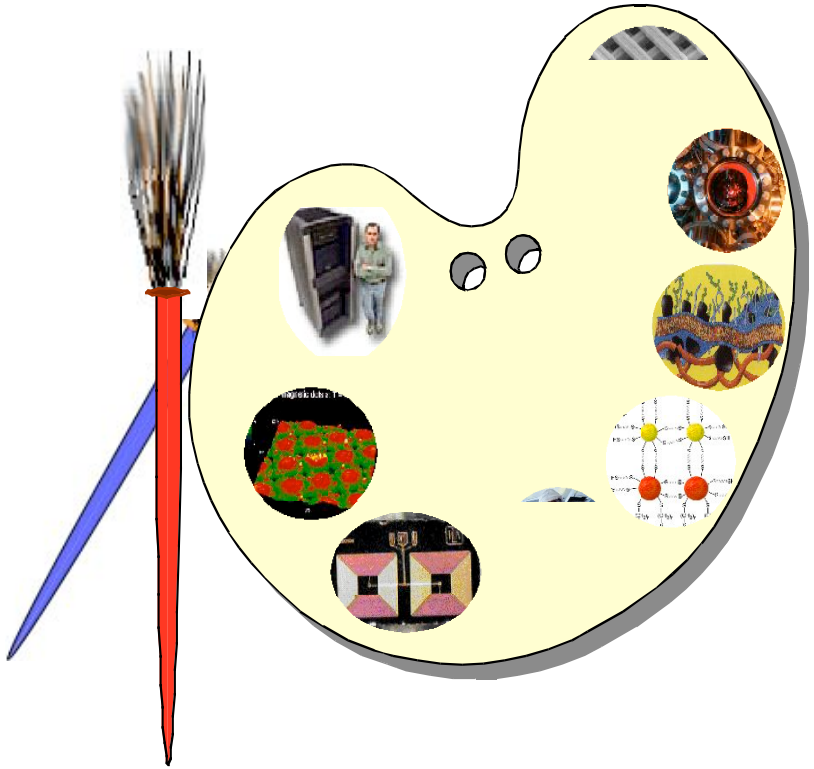
CINT: A National user facility for nanoscience integration research



Upcoming Events

4th CINT Users Workshop
Albuquerque, NM
January 12-13, 2006

Next Call for User Proposals:
January 2006

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http://CINT.sandia.gov *or* http://CINT.lanl.gov

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